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BY ARTHUR E. J. WENT.

(PLATES 1 AND 2)

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Introduction.

The Owengowla or Gowla River is a small river in Connemara in the west of Ireland which supports a fairly heavy stock of sea trout, a few salmon, and some small brown trout. According to Hely Hutchinson (*Tables of Irish Rivers,* 1901)

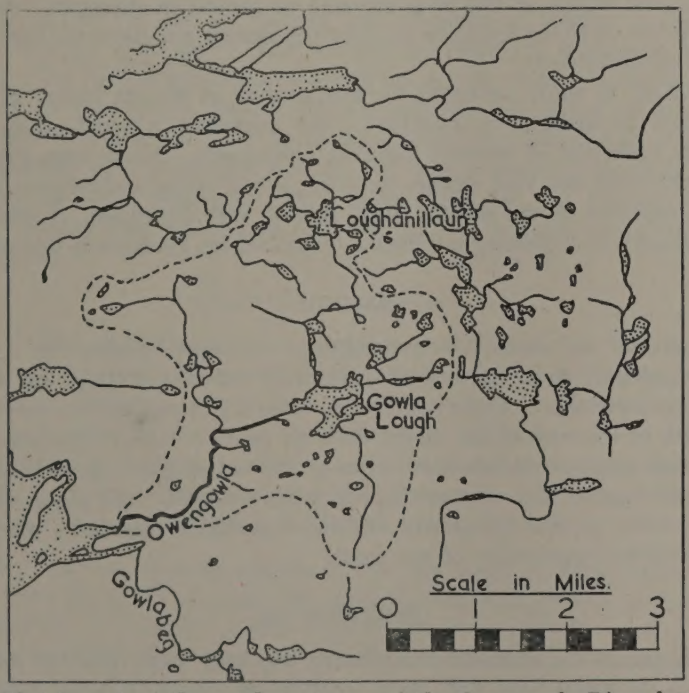

Fig. 1. *Sketch map of the catchment area of the Owengowla River based on the Ordnance Survey by permission of the Minister for Finance. Boundary of catchment area of the Owengowla indicated as a broken line.*

it has a length of 8½ miles with a catchment area of 19½ square miles. The same writer also states that the highest point in the catchment area is 216ft. above sea level only, but certainly one of the small tributaries drains a hill 630ft. high. It is true, however, that the catchment area is low-lying, and the greatest fall in the river is between the sea and the lake shown on the Ordnance Maps as Loughanillaun but known locally as Gowla Lake. A waterfall at the tideway formerly made conditions difficult for the ascent of fish, but in the year 1942, a fish pass designed by the late P. L. Healy, B.E., when he was Fisheries Engineer in the Department of Agriculture, was erected to eliminate this obstacle. This fish pass (Plate I. A) now permits fish to run into the freshwater portion of the river under most heights of river water when they are likely to run. Between the lowest bridge over the river and Loughanillaun there are a number of good fishing pools, each bearing a name (see Figure 1 for sketch map of catchment area).

The rocks of the catchment area contain little or no lime. Most of the area consists of metamorphic rocks (mica and hornblende schists) of the Lower Silurian. Although somewhat to the north of this area there are extensive thin limestone bands in these rocks, they do not occur in the Owengowla catchment area. Some areas of hornblende rocks and smaller areas of granite and of intrusions of felstone also occur. As calcium compounds are virtually absent in the rocks of the catchment area, the waters of this river are acid or neutral in character. Analyses of water from two selected localities on the river system are given in Table 1. (See Appendix for all tables).

G. H. Nall, in 1931, published the first account of the life history of Irish sea trout based on satisfactory material. He examined a small, but obviously inadequate, collection of material from the Owengowla. From 1942 onwards Mr. E. C. Micks, S.C. was kind enough to collect sets of scales and relevant data from sea trout captured in the months July, August and September. I wish to take this opportunity of expressing my thanks to him for his kindness in this connection.

Material.

The material on which this investigation was based consisted of 431 sets of scales and relevant data. 34 sets of scales were collected in July, 251 in August, and 146 in September. Unfortunately we have no means of estimating directly the strength of the runs of fish in the different months, but observations made by local persons suggest that fish start to run at the end of June, increase in numbers in July and August, and decrease in September. Angling took place during each of these months, so that the present material is probably reasonably representative of the incoming populations of sea trout.

Nomenclature.

In this paper the normal nomenclature has been used, but for the sake of clarity it is described here. Sea trout eggs are deposited in gravel from October to January, and, after a period depending mainly on the prevailing temperature, a small fish or alevin emerges from the eggshell. This alevin exists for a time on

the substance in the yolk sac, which is gradually used up, but before its final disappearance the small creature leaves the gravel, and commences to feed. Gradual pigmentation of the skin takes place, and the fish is then described as a parr. After a period of feeding in fresh water the parr obtains a silvery colouration; it is now a smolt, and descends the river to the sea, where it feeds for a period, the length of which depends on the individual fish. Some fish may return to fresh water as clean fish after a period of only three months. Others spend just over a year, just over two years, or more rarely just over three years, feeding in the sea before returning to fresh water. In the succeeding October to January they usually spawn and return as kelts or unclean fish to the sea. They may make one or more returns to fresh water as clean fish getting larger and larger after each return.

Clean sea trout are classified into maiden or unspawned fish and previous spawners. Maiden sea trout are primarily classified by "age group," that is to say, on the period spent feeding in the sea. Whitling or finnock are fish which have spent a portion of a summer only in the sea, and for convenience they are said to be in their first post-migration summer. They are indicated by the symbol +, more properly 0+, but for simplicity the 0 is omitted. Larger maiden fish are described as in their second, third, or very rarely fourth, post-migration summers, and are indicated by the symbols 1+, 2+, and 3+, respectively. The term "class" is reserved for the various age categories of smolts, 1 year smolt class, 2 years smolt class etc. The symbols in Tables 7, 9 14 and 16 need explanation. The first figure indicates the smolt age (**2**, **3** etc.) in years and the symbol +, **1+**, **2+**, or **3+**, which follows indicates the period of sea feeding before the first return to the river as a clean adult fish. Then may follow the symbol **SM**, **2SM**, etc., indicating that the fish was a previous spawner, having spawned once or twice previously. The symbol **SM** etc., is followed by the symbol + denoting that since spawning less than a complete year was spent feeding in the sea.

Results of Analysis.

Smolt Ages: The distribution of the various smolt classes has been given in Table 2. Two-year smolts comprised about three-quarters of the total catch, and the bulk of the remaining 23.7% were three-year smolts. In this respect the Owengowla is similar to the Inny (Went, 1948). These two rivers have the highest proportion of two-year smolts recorded in Irish sea trout to date (Nall, 1931 and Went, 1944). The proportion of older smolts (three and four-years) decreased as the period spent feeding in the sea increased (Table 3).

Smolt Types: In two previous papers on the sea trout of Irish rivers it was pointed out that the scales of some fish showed freshwater growth in the spring prior to migration as a smolt. These were described as type B. smolts. Other fish, however, showed little or no such growth, and the smolts were described as type A. smolts. In the present material a similar division was to be observed, and the relevant details have been tabulated in Table 4. It will be seen that the proportion of type A smolts increased as the smolt classes were ascended.

Age Groups: In Table 5. the distribution into the various age groups has been given, and it was shown that 83.3% of the fish were in their first, and 11.6% in their second post-migration summer. Previous spawners only amounted to 4.2% of the total, a figure which is considerably lower than that of any other Irish river investigated to date. The age in years of the fish is given in Table 6. From this it will be seen that, assuming + growth to represent a half year, the average age of the stocks was 2.98 years. Photographs of the scales of seven fish are given in Plates 1 and 2.

Age at Maturity and Number of Spawning Marks: Scales from eighteen previous spawners were examined and of these six had spawned for the first time as whitling or finnock, eleven as fish in their second post-migration year and only one in its third post-migration summer. Three previous spawners had two spawning marks on their scales and the remainder only one such mark .

Average Size: Mean weights and lengths were calculated for each age category and the results are given in Table 7. It will be noted that in each smolt class there is a rise in the mean length as the period spent in the sea increases. Also previously spawned fish were longer than the equivalent category of unspawned fish; for example the **3+ SM+** group had a mean length of 14.1" against the **3+** category's value of 11.3".

For convenience the mean lengths of the different age groups irrespective of smolt class have been calculated in Table 8. As regards the minimum and maximum lengths and, incidentally, weights, these follow the same sequence as the mean values, as of course might have been expected if adequate material was examined (see also Figure 2).

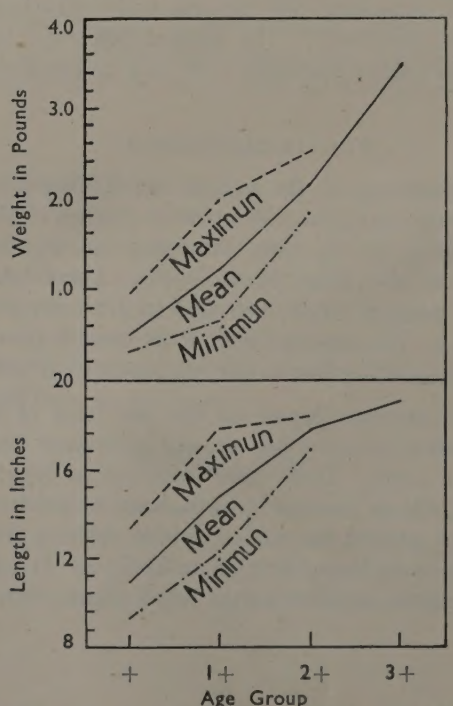

FIG. 2. *The minimum, mean and maximum weights and lengths in the different groups of maiden fish.*

The heaviest fish of which scales were obtained weighed $3\frac{3}{4}$ lb. It was taken on 21st August, 1942, and was 21.8 inches in length. As there was no erosion of its scales it probably had entered fresh water only a short time before capture. *Size Distribution*: Four hundred and twenty of the fish only were measured and the length distributions are given in Table 9, and illustrated graphically in Fig. 3. Approximately 88% of the total catch had lengths below 14 inches (about 1.25 lb. in weight). Owengowla sea trout were, therefore, probably somewhat smaller than those of other rivers in the west of Ireland.

Oldest Fish: The oldest fish in this collection was in its seventh year, and even the proportion of fish a year younger was low, *i.e.* 1.9%. With a low average age such as now recorded (about 3 years, see p. 58) large fish were not to be expected.

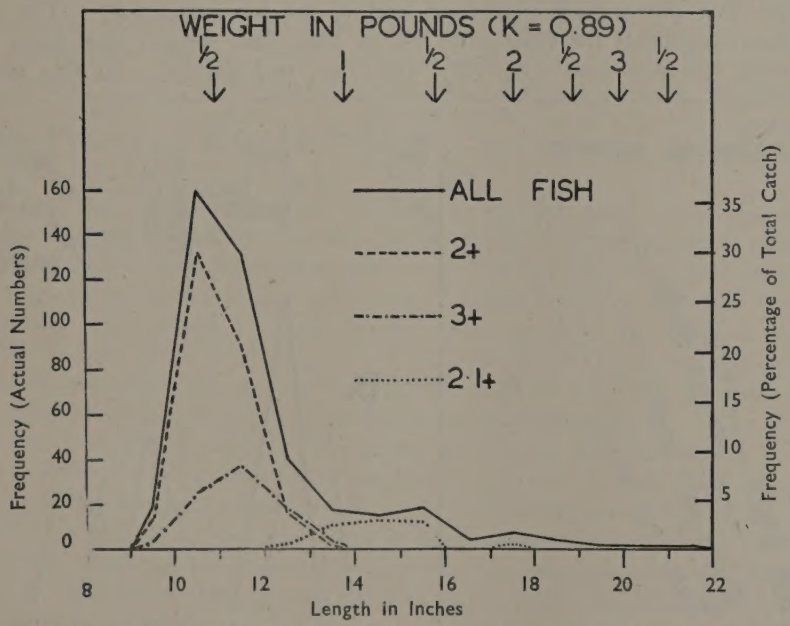

FIG. 3. *Estimated size distribution of the stocks of the Owengowla. (The weight scale was calculated on the basis of* K=0.89, *the mean value obtained in these investigations).*

Erosion of the Scales: Erosion of the scales of a maturing sea trout normally takes place after sojourn in fresh water, although it may take place also in the sea if fish are prevented from ascending a river for some reason or other. In Table 10 the proportion of fish in the different age groups and smolt classes having eroded scales has been given. It will be seen that fewer fish in their first post-migration summer had eroded scales than fish which had spent longer feeding in the sea before returning to the river to spawn. The mean degree of erosion (see Menzies, 1931) was also markedly different. That this is not entirely due

to different dates of capture may be seen from Table II in which the percentage of each age group captured in the different months has been given. This difference in the erosion of the scales may be attributed to the fact that fish in their second and later post-migration summers entered the rivers earlier than those in their first post-migration summer.

Condition Coefficient: In order to compare the weight/length relationship of fish at different periods of the year and in different age groups, workers of the former Fishery Board for Scotland, now the Scottish Home Department, devised a condition coefficient for this purpose. This coefficient (K) is calculated according to the formula $K = W/(L^3 \times 0.000427)$, where W is the weight in pounds and L is the length in inches. Using this formula Nall (1930) found that in Scotland in good summer condition a value of 0.95 was obtained for whitling or finnock (fish in their first post-migration summer) and of 1.0 for larger fish. The mean condition coefficients for Owengowla fish in their first, second, and third, post-migration summers were 0.89, 0.87, and 0.90, respectively. In this respect,

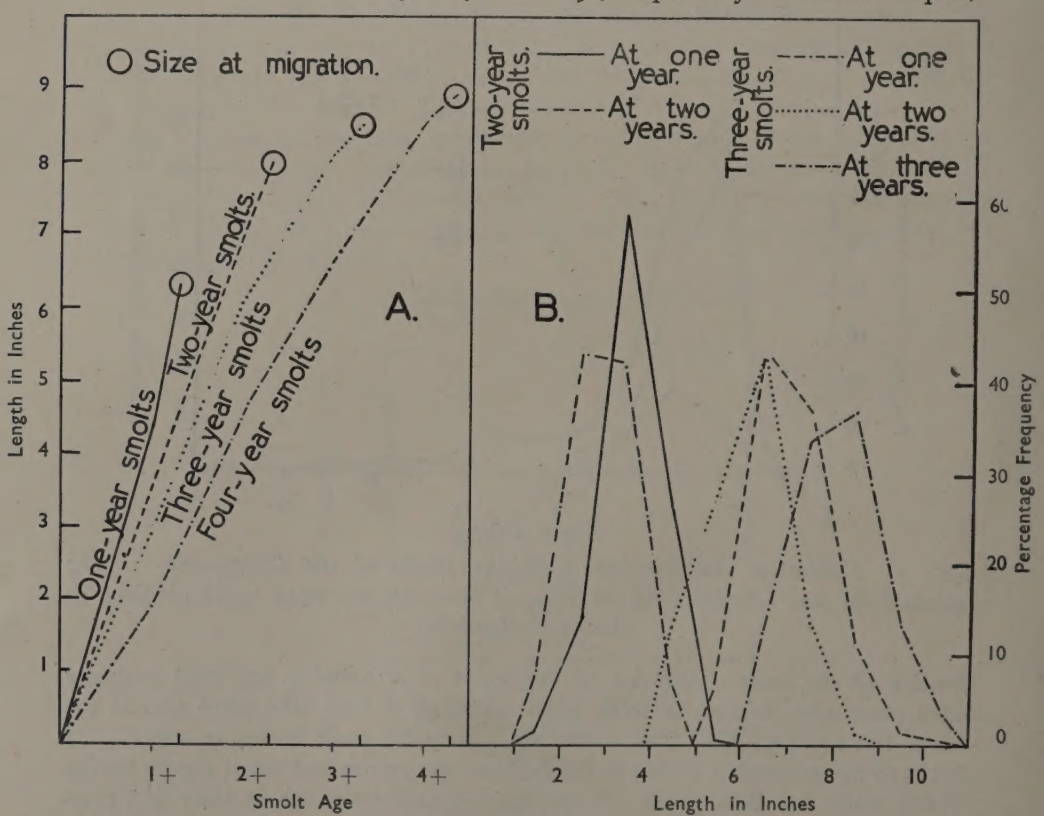

FIG. 4. A.—*Growth curves for the different smolt classes* B.—*Frequency distribution curves for the two and three year smolt classes at the end of each year of fresh water life.*

therefore, sea trout of the Owengowla River are somewhat slimmer, length for length, than Scottish sea trout, but agree closely with sea trout of the Waterville (Currane) River (Went, 1944).

Divided Migration and Return: In Table 12 the divided migration and return of the various fish has been indicated. Two year classes (*i.e.* fish in their third and fourth years) contributed over 90% of the total catch.

Growth Calculations: In each maiden fish having satisfactory scales the growth rate was calculated in the usual way, *i.e.* on the basis that the growth of the scale was proportional to the growth of the fish. In Table 13 the growth in fresh water in the different smolt classes has been given (see also Fig. 4). It will be noted that the fastest growing parr migrated first, and that there was an increase in the mean smolt length as the smolt classes are ascended. Whilst in general the freshwater growth rate was somewhat higher than that of the Inny (Went, 1948) it was lower than that of the Waterville River (Went, 1944). The estimated mean lengths of the smolts were:—Owengowla, 8.1 inches; Inny, 7.5 inches; Waterville River, 9.9 inches. In addition to the growth curves, frequency distribution curves for the two and three-year smolt classes at different periods of life have been indicated in Fig. 4.

For each age category the mean growth rate was calculated (Table 14). The mean smolt size of the fish entering the river in their second post-migration summer was slightly higher than that of fish entering in their first post-migration summer.

On page 57 it was stated that two types of smolts could be observed in each smolt class. The growth rates of the two smolt types in the different smolt classes have been given in Table 15. In each smolt class having a reasonable number of individuals the growth rate in fresh water in the Type A smolts was slightly greater than in the Type B smolts of the same year class.

Fish in their first post-migration summer put on 2.9 inches in length in the sea (see Table 16). This increment was made in a few months. The increase in length in the first post-migration year in the case of the remaining maiden fish was only 3.4 inches, a difference which is small considering the extra period of sea feeding. Possibly the explanation of this is that, as in the case of growth in salmon fry and brown trout (see Frost and Went, 1940 and Went and Frost, 1942), rapid or summer growth in the sea may be restricted to a few months. In consequence, such growth may be almost completed by the time the whitling or finnock run into the fresh water. As the age groups are ascended there seems to be a tendency for the increment in the last summer or part thereof to decrease slightly (see Table 16).

SUMMARY.

(*a*) Material, consisting of 431 sets of scales and relevant data from sea trout captured in a small river in the West of Ireland, was examined.

(*b*) The bulk of the fish were derived from two-year smolts, the three-year smolts being, however, quite important (Table 2). Two smolt types were observed as in previous investigations (Table 4).

(*c*) Five-sixths of the total catch were fish in their first post-migration summer (Table 5). The average age was approximately 3 years (Table 6).

(*d*) In Tables 7 and 8 minimum, mean, and maximum, weights and lengths in the different age categories have been given (see also Fig. 2), and the size distributions have been indicated in Table 9 (see also Fig. 3). Low condition coefficients (mean 0.89) were recorded.

(*e*) The youngest age group showed less erosion of the scales than the other age groups. That this was due to the late entry into fresh water was indicated in Tables 10 and 11.

(*f*) Divided migration and return of the different fish has been indicated in Table 12.

(*g*) Growth rates of all maiden fish were calculated in the usual way (Tables 13-16). It was shown that the fastest growing parr migrated first, and that there was an increase in the mean smolt lengths as the smolt classes were ascended (Table 13). The mean smolt length of fish entering the river in their second post-migration summer was slightly higher than in fish entering in their first post-migration summer. Growth in the Type B smolts was slightly slower than in the Type A smolts of the same smolt class (Table 15). Increments made in the sea in the summer of migration compared favourably with those made in a full year (Table 16). The probable explanation of this is that Owengowla sea trout run late in the year when the period of rapid growth in the sea is nearing its completion.

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Table 1. Analysis of samples of water taken from the Owengowla and Loughanillaun (Gowla Lake) Mgs. per litre (parts per million).

	Total dissolved solids		Chlorine	Silica	Iron	Calcium	Magnesium	Sodium	Potassium
	Fixed	Volatile	Cl.	SiO_2	Fe_2O_3	CaO	MgO	Na_2O	K_2O
Owengowla	4.2	2.0	2.2	Less than 0.1	0.01	Trace	0.4	1.96	Trace
Loughanillaun	4.0	2.0	2.1	do.	0.01	do.	0.4	1.86	do.

(Analysis carried out by staff of the State Laboratory, Dublin)

Table 2. Proportion of the different smolt ages (maiden fish only) as percentages of each age group.

Age Group	Smolt Age				Total
	One Year	Two Years	Three Years	Four Years	
First post-migration summer	0.6	73.3	25.0	1.1	100.0
Second post-migration summer	-	84.0	16.0	-	100.0
Third post-migration summer	-	100.0	-	-	100.0
Total	0.5	74.8*	23.7	1.0	100.0

* Including one fish in its fourth post-migration summer.

Table 3. Distribution of the various age groups in each smolt class (as percentages). Maiden fish only.

Age Group	Smolt Age				Total
	One Year	Two Years	Three Years	Four Years	
First post-migration summer	100.0	85.1	91.8	100.0	87.0
Second post-migration summer	-	13.6	8.2	-	12.1
Third post-migration summer	-	1.0	-	-	0.7
Total	100.0	100.0*	100.0	100.0	100.0*

* Including 0.3% in their fourth post migration summer.

Table 4. Proportion of smolt types in each smolt age.

Smolt Age	Smolt Type				Total	
	A		B			
	No.	%	No.	%	No.	%
1	-	-	2	100.0	2	100.0
2	21	6.8	288	93.2	309	100.0
3	31	31.6	67	68.4	98	100.0
4	3	75.0	1	25.0	4	100.0
Total	55	13.3	358	86.7	413	100.0

Table 5. Distribution into the various age groups (period feeding in the sea).

	Age Group (in winters)					Total
	+	1+	2+	3+	With S.Ms.	
No.	359	50	3	1	18	431
%	83.3	11.6	0.7	0.2	4.2	100.0

Table 6. Numbers and percentages of fish of different ages.

	Age in winters					
	1+	2+	3+	4+	5+	6+
No.	2	263	134	23	8	1
%	0.5	61.0	31.1	5.3	1.9	0.2

Table 7. Minimum, mean and maximum weights and length in the various age categories.

Age Category	Number examined	Weight in lb.			Length in inches		
		Min.	Mean	Max.	Min.	Mean	Max.
1+	1	-	0.31	-	-	9.3	-
2+	258	0.31	0.48	0.88	9.3	10.8	13.4
2.SM+	2	0.88	1.0	1.13	13.0	13.8	14.5
3+	87	0.31	0.56	0.94	9.8	11.3	13.3
3+SM+	3	0.81	1.27	2.0	12.8	14.1	17.0
3+2SM+	1	-	1.98	-	-	17.3	-
4+	4	0.5	0.65	0.75	10.0	11.4	12.5
2.1+	40	0.63	1.20	1.75	12.5	14.8	17.4
2.1+SM+	5	1.31	1.82	2.37	15.8	16.9	18.8
2.1+2SM+	1	-	3.75	-	-	21.8	-
3.1+	8	0.75	1.26	2.0	12.3	14.8	17.8
3.1+SM+	4	1.37	1.55	1.75	15.5	16.5	17.5
3.1+2SM+	1	-	1.88	-	-	17.0	-
2.2+	3	1.82	2.17	2.5	17.0	17.8	18.3
2.2+SM+	1	-	3.63	-	-	20.9	-
2.3+	1	-	3.5	-	-	19.1	-

Table 8. Minimum, mean and maximum weights and lengths in the various age groups.

Age Group	Number Examined	Weight in lb.			Length in inches		
		Min.	Mean	Max.	Min.	Mean	Max.
+	350	0.31	0.49	0.94	9.3	10.9	13.4
1+	48	0.63	1.21	2.00	12.3	14.8	17.8
2+	3	1.82	2.17	2.50	17.0	17.8	18.3
3+	1	-	3.50	-	-	19.1	-

Table 9. Size distribution (in inches) in the various age categories.

Class Interval*	Age categories									Total	
	1+	2+	3+	4+	2.1+	3.1+	2.2+	2.3+	With SMs.	No.	%
9	1	16	3	-	-	-	-	-	-	20	4.8
10	-	132	26	1	-	-	-	-	-	159	37.7
11	-	92	38	1	-	-	-	-	-	131	31.2
12	-	17	18	2	2	1	-	-	1	41	9.8
13	-	1	2	-	11	2	-	-	2	18	4.3
14	-	-	-	-	14	-	-	-	1	15	3.6
15	-	-	-	-	12	3	-	-	3	18	4.3
16	-	-	-	-	-	1	-	-	3	4	1.0
17	-	-	-	-	1	1	1	-	4	7	1.7
18	-	-	-	-	-	-	2	-	2	4	1.0
19	-	-	-	-	-	-	-	1	-	1	0.2
20	-	-	-	-	-	-	-	-	1	1	0.2
21	-	-	-	-	-	-	-	-	1	1	0.2
Total	1	258	87	4	40	8	3	1	18	420ø	100.0

* Class interval 9 etc. includes all fish between 8.95 and 9.95 inches in length.

ø Remaining eleven fish were not measured.

Table 10. Proportion of fish having eroded scales and mean degree of erosion.

Age Group	Smolt Age	Percentage with eroded scales	Mean degree of erosion
+	1	Nil	Nil
	2	2.3	0.02
	3	2.2	0.02
	4	Nil	Nil
1+	2	57.2	0.8
	3	50.0	0.8
2+	2	100.0	3.0
3+	2	100.0	1.0
With SMs.	All smolts	33.3	0.4
Total	All smolts	10.4	0.15

Table 11. Percentage of each age group captured in each month.

Month	Age Group						Total	
	+		1+		With SMs.			
July	8.1	29	10.0	5	-	-	7.9	34
August	58.7	211	52.0	26	67.0	12	58.2	251
September	33.2	119	38.0	19	33.0	6	33.9	146
Total	100.0	359	100.0	50	100.0	18	100.0	431

NOTE: Figures underlined are number of fish examined.

Table 12. Freshwater growth (lengths in inches) in the different smolt classes.

Returned in 1941 as fish in	Mean length at end of						Total
	1935	1936	1937	1938	1939	1940	
1st Post Migration Summer	-	-	0.9	20.9	61.2	0.5	83.4
2nd Post Migration Summer	-	-	1.8	9.8	-	-	11.6
3rd Post Migration Summer	-	-	0.7	-	-	-	0.7
4th Post Migration Summer	-	0.2	-	-	-	-	0.2
Previous spawners	0.2	1.6	1.8	0.5	-	-	4.1
Total	0.2	1.8	5.2	31.2	61.2	0.5	100.0

Table 13. Freshwater growth (lengths in inches) in the different smolt classes.

Smolt Age	Number Examined	Mean length at end of				Mean Smolt Length
		1st Year	2nd Year	3rd Year	4th Year	
1	1	4.4	-	-	-	6.3
2	302	3.6	7.0	-	-	8.0
3	95	2.9	6.1	8.1	-	8.5
4	4	1.9	4.6	6.7	8.6	8.9

Table 16. Increment in inches made in the different years in the sea in the different age categories.

Age Category	No.	Increment in			
		1st Sea Year	2nd Sea Year	3rd Sea Year	4th Sea Year
1+	1	3.0*	-	-	-
2+	258	2.9*	-	-	-
3+	87	2.8*	-	-	-
4+	4	2.5*	-	-	-
2.1+	40	3.4	2.7*	-	-
3.1+	8	3.4	2.3*	-	-
2.2+	3	3.4	3.8	2.5*	-
2.3+	1	3.4	3.0	2.8	1.8*

* Incomplete year as fish entered fresh water before the end of the year.

Table 14. Mean lengths in inches at the end of the different years of river and sea life in the various age categories.

Age Category	Number Examined	River Life				Mean Smolt Length	Sea Life			Mean Length at Capture
		1st Year	2nd Year	3rd Year	4th Year		1st Year	2nd Year	3rd Year	
1+	1	4.4	-	-	-	6.3	-	-	-	9.3
2+	258	3.5	6.9	-	-	7.9	-	-	-	10.8
3+	87	2.9	6.0	8.1	-	8.5	-	-	-	11.3
4+	4	1.9	4.6	6.7	8.6	8.9	-	-	-	11.4
2.1+	40	3.8	7.6	-	-	8.7	12.1	-	-	14.8
3.1+	8	3.1	6.5	8.5	-	9.1	12.5	-	-	14.8
2.2+	3	3.5	7.0	-	-	8.1	11.5	15.3	-	17.8
2.3+	1	3.8	6.9	-	-	8.1	11.5	14.5	17.3	19.1

Table 15. Mean lengths in inches at the end of the different years or river life in the two smolt types of each smolt class.

Smolt Age	Type A Smolts						Type B Smolts					
	No. Examined	Mean length at end of				Mean smolt size	No. Examined	Mean length at end of				Mean smolt size
		1st Year	2nd Year	3rd Year	4th Year			1st Year	2nd Year	3rd Year	4th Year	
1	-	-	-	-	-	-	1	4.4	-	-	-	6.3
2	20	3.8	7.5	-	-	7.5	282	3.6	7.0	-	-	8.1
3	28	3.1	6.3	8.5	-	8.5	67	2.8	6.0	7.9	-	8.6
4	3	1.9	4.7	6.5	8.3	8.3	1	1.8	4.3	7.3	9.3	10.5

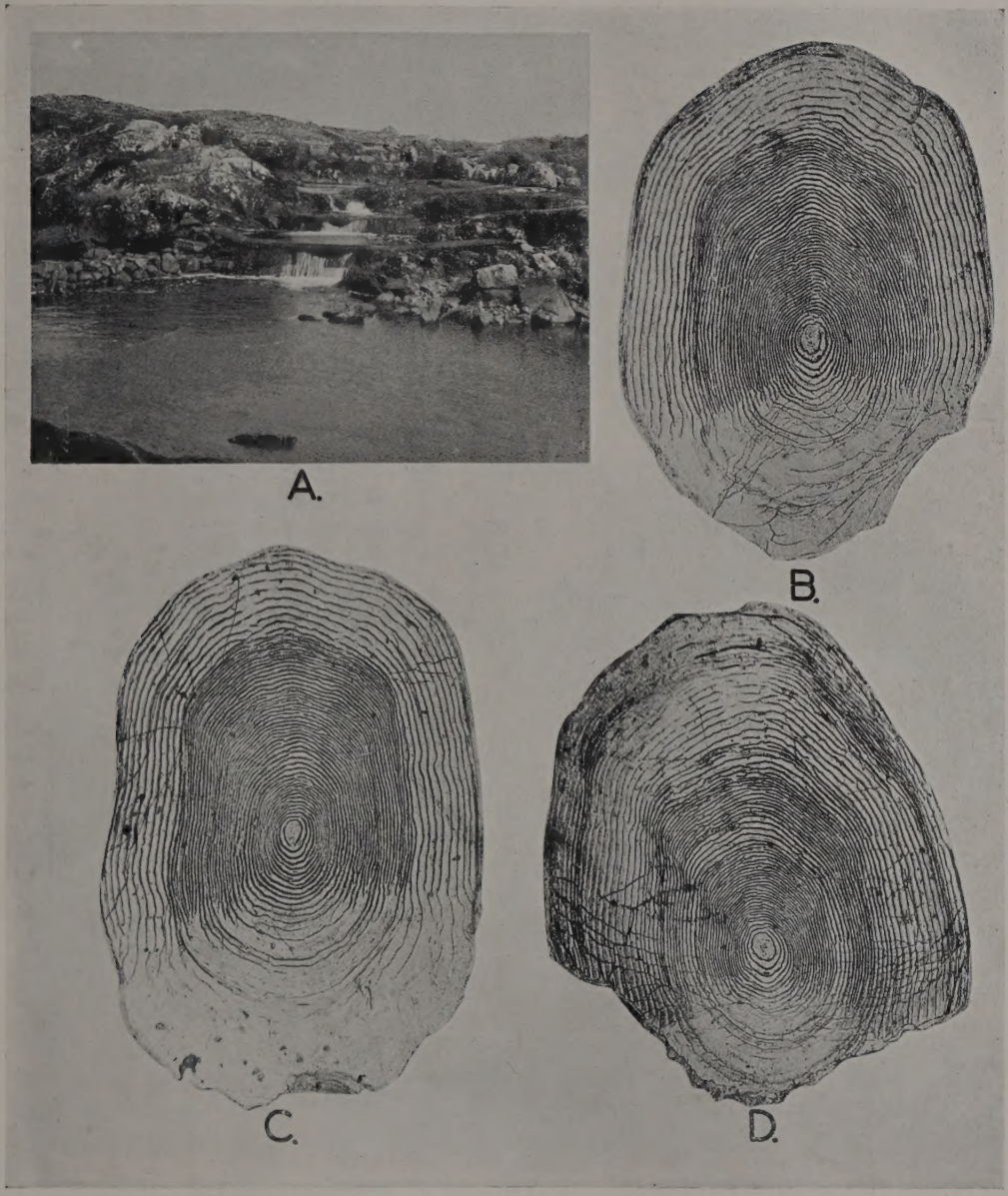

PLATE 1. A.—*Fish pass at mouth of the Owengowla.*
B.—*Scale of finnock* (2+) 10.3 *inches,* 6.5 *ozs. taken on 4th August,* 1943. *Magnification* 23.
C.—*Scale of finnock* (3+) 11 *inches,* 8 *ozs. taken on 4th August,* 1943. *Magnification* 23.
D.—*Scale of a sea trout* (2.1+) 15.3 *inches,* 1 *lb.* 6 *ozs. taken on 12th September,* 1944. *Magnification* 25.

PLATE 2. *Scales of sea trout.*

A.—(2.2+) 18.3 *inches* 2 *lb.* 8 *ozs. taken on 6th August,* 1946. *Magnification* 23.

B.—(2.1+SM+) 15.8 *inches* 1 *lb.* 11 *ozs. taken on 9th August,* 1946. *Magnification* 16.

C.—(3.1+SM+) 15.5 *inches* 1 *lb* 6 *ozs. taken on 4th August,* 1943. *Magnification* 22.

D.—(2.2+SM+) 20.9 *inches* 3 *lb.* 10 *ozs. taken on 8th August,* 1943. *Magnification* 20.